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Taylor et al.

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(54) **AUTOMATED NETWORK SUPERVISION INCLUDING DETECTING AN ANONYMOUSLY ADMINISTERED NODE, IDENTIFYING THE ADMINISTRATOR OF THE ANONYMOUSLY ADMINISTERED NODE, AND REGISTERING THE ADMINISTRATOR AND THE ANONYMOUSLY ADMINISTERED NODE**

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G06N 20/00 (2019.01)
H04L 29/08 (2006.01)

(52) **U.S. Cl.**

CPC ***H04L 41/16*** (2013.01); ***G06N 20/00*** (2019.01); *H04L 41/20* (2013.01); *H04L 67/10* (2013.01)

(58) **Field of Classification Search**

CPC H04L 41/16; H04L 67/10; H04L 41/20; G06N 20/00

See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Farjami & Farjami LLP

(57) **ABSTRACT**

According to one implementation, a network supervision system includes one or more computing platform(s) coupled to multiple nodes of a network including the computing platform(s), the computing platform(s) including a hardware processor and a system memory storing a network participant supervising software code and a network participant registry. The hardware processor executes the network participant supervising software code to detect an anonymously administered node of the network, aggregate system log files of the anonymously administered node, and perform an analysis of the system log files using an unsupervised machine learning algorithm to identify an administrator of the anonymously administered node. The hardware processor further executes the network participant supervising software code to generate a registration record associating the administrator with the anonymously administered node, and update the network participant registry using the registration record.

20 Claims, 4 Drawing Sheets

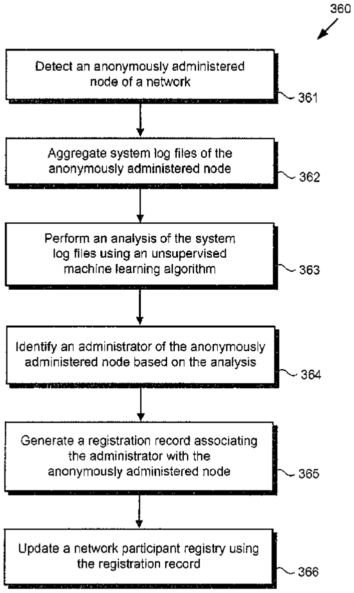
360
Detect an anonymously administered node of a network
361
Aggregate system log files of the anonymously administered node
362
Perform an analysis of the system log files using an unsupervised machine learning algorithm
363
Identify an administrator of the anonymously administered node based on the analysis
364
Generate a registration record associating the administrator with the anonymously administered node
365
Update a network participant registry using the registration record
366

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Fig. 1

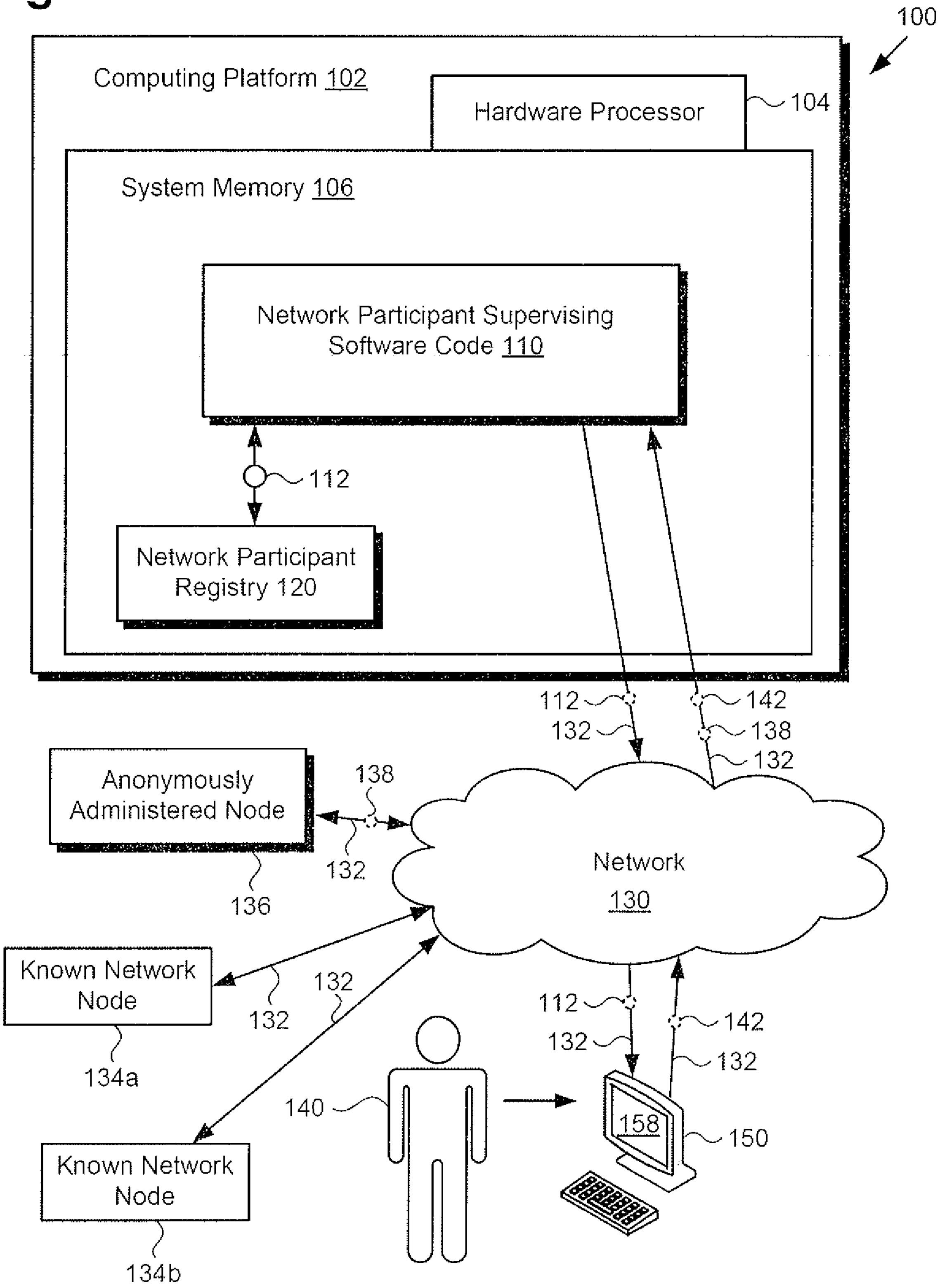

100
Computing Platform 102
Hardware Processor
104
System Memory 106
Network Participant Supervising Software Code 110
112
Network Participant Registry 120
112
132
142
138
132
Anonymously Administered Node
138
132
136
Network
130
Known Network Node
132
134a
132
Known Network Node
134b
140
112
132
142
132
158
150

Fig. 2

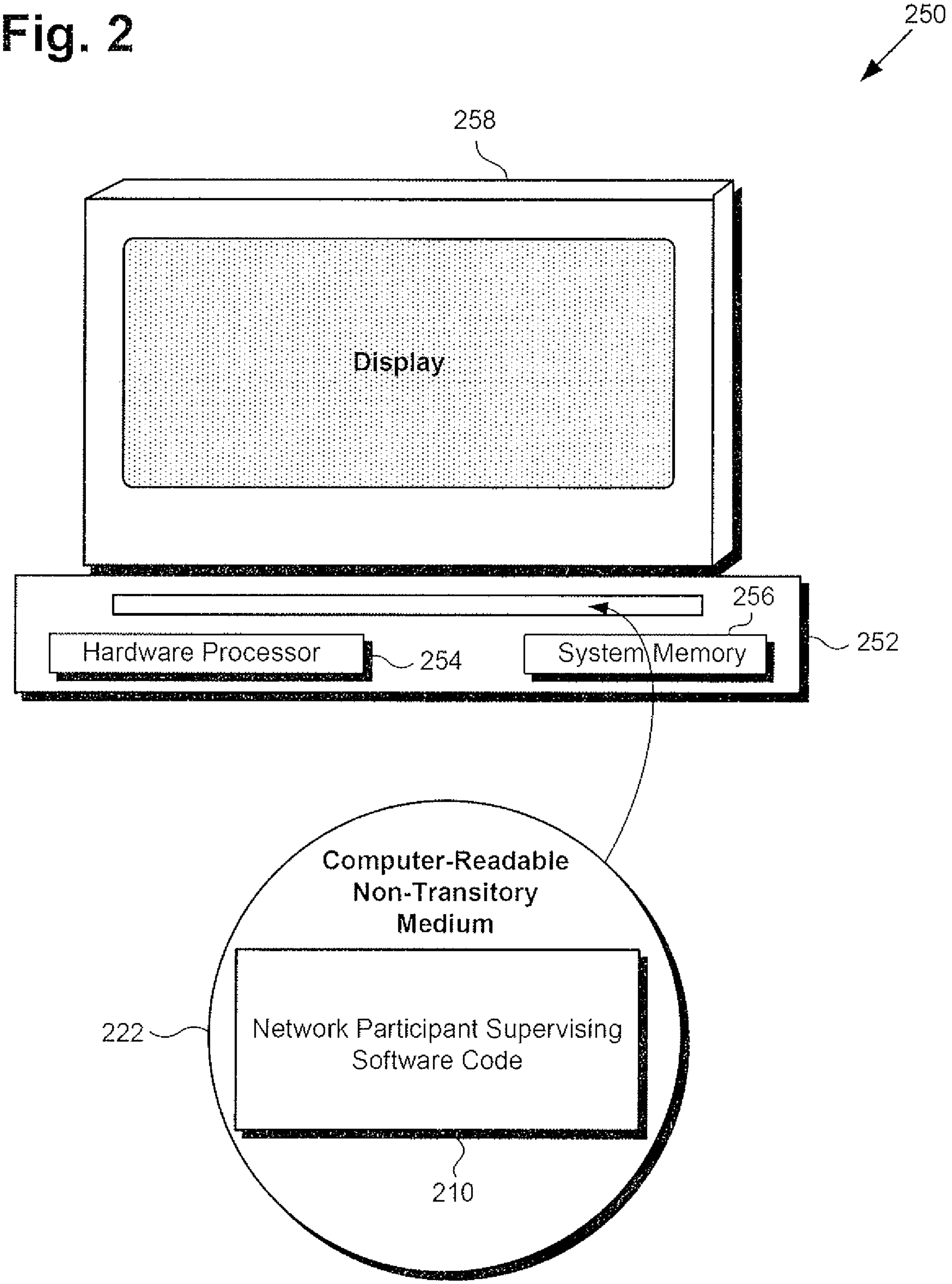
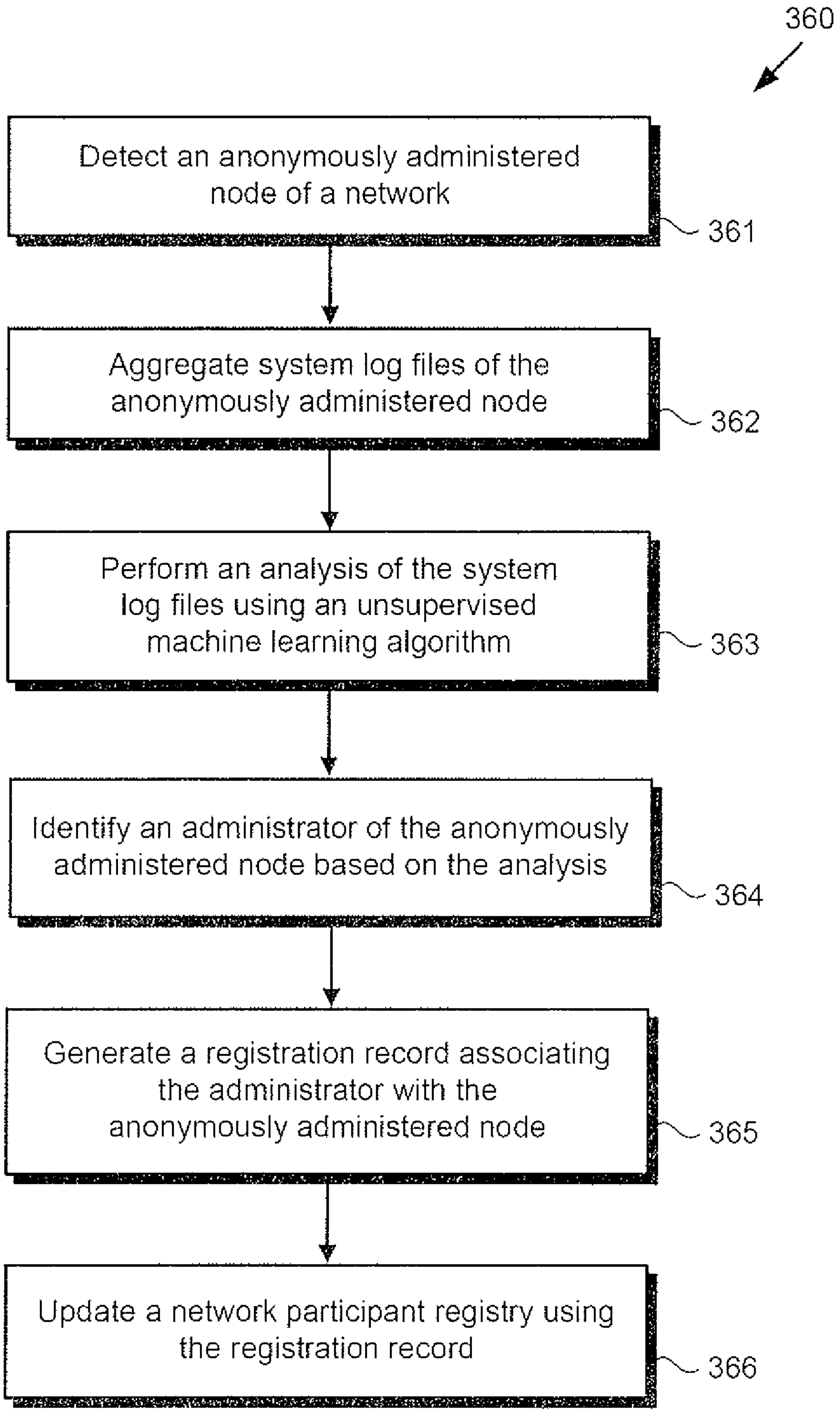

250
258
Display
256
252
Hardware Processor
254
System Memory
Computer-Readable Non-Transitory Medium
222
Network Participant Supervising Software Code
210

Fig. 3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Detect an anonymously administered node of a network
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Perform an analysis of the system log files using an unsupervised machine learning algorithm
363
Identify an administrator of the anonymously administered node based on the analysis
364
Generate a registration record associating the administrator with the anonymously administered node
365
Update a network participant registry using the registration record
366

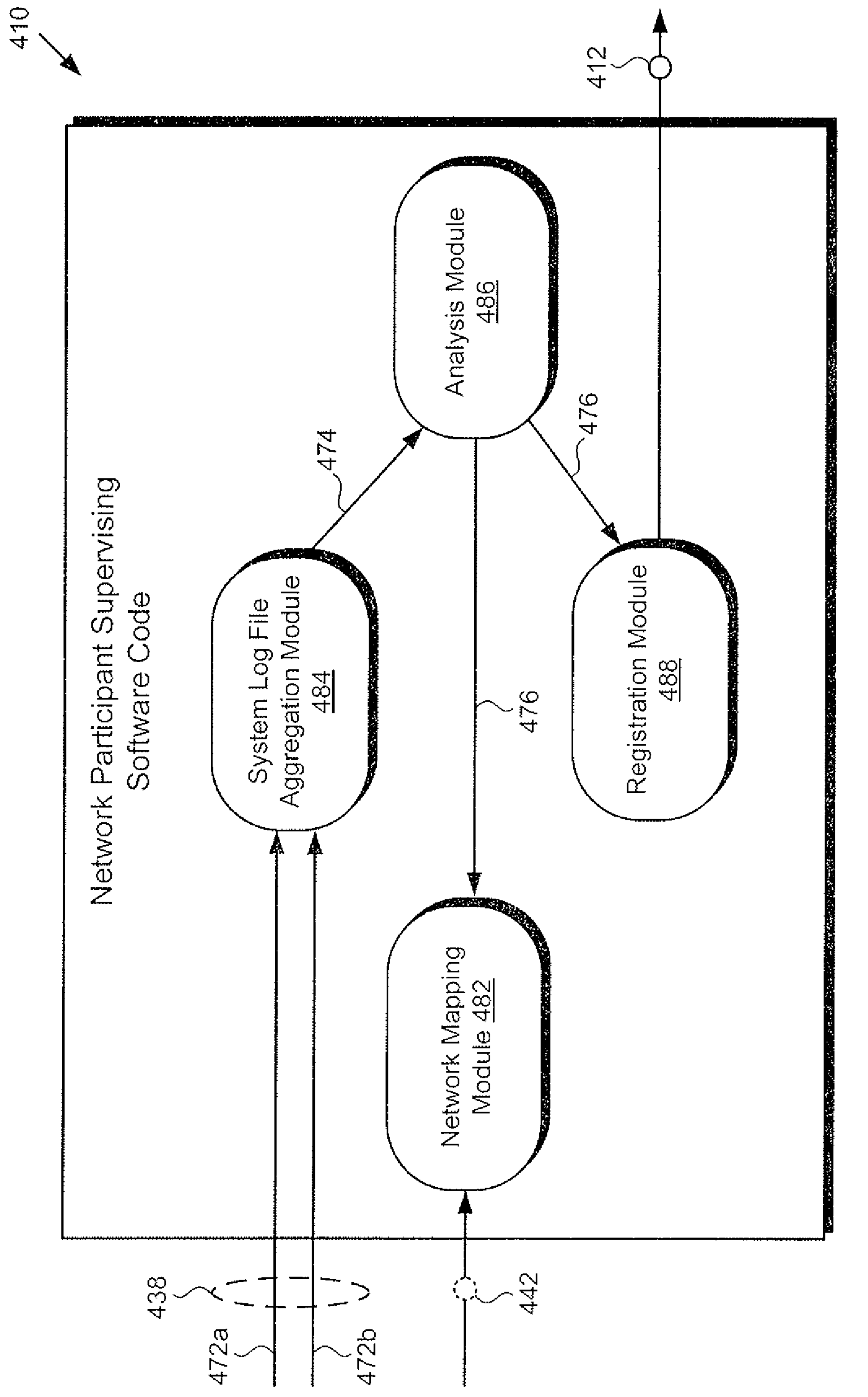
410
Network Participant Supervising Software Code
System Log File Aggregation Module 484
Analysis Module 486
Registration Module 488
Network Mapping Module 482
474
476
476
412
438
472a
472b
442

Fig. 4

AUTOMATED NETWORK SUPERVISION INCLUDING DETECTING AN ANONYMOUSLY ADMINISTERED NODE, IDENTIFYING THE ADMINISTRATOR OF THE ANONYMOUSLY ADMINISTERED NODE, AND REGISTERING THE ADMINISTRATOR AND THE ANONYMOUSLY ADMINISTERED NODE

BACKGROUND

A large organization, such as a government entity, large corporation, or university, for example may utilize a communication network having thousands or hundreds of thousands of technology nodes. Each of those nodes may correspond to a technology device, such as a personal communication device or client computer system, for example, or to a software application used across the network. In such a la use environment, identification of the owner or administrator of each technology device and software application can be important for effective management of the network.

Conventional solutions for managing an organizational network tend to rely on pre-registration of network device or application owners and administrators, or seek to identify a network connected device or application directly. The process for identifying a technology device or application according to the conventional approach often includes a relatively costly and inconvenient manual investigation to identify its owner or administrator.

SUMMARY

There are provided automated network supervision systems and methods for use by such systems, substantially as shown in and/or described in connection with at least one of the figures, and as set forth more completely in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a diagram of an exemplary automated network supervision system, according to one implementation;

FIG. **2** shows an exemplary system and a computer-readable non-transitory medium including instructions for performing automated network supervision, according to one implementation;

FIG. **3** shows a flowchart presenting an exemplary method for performing automated network supervision, according to one implementation; and

FIG. **4** shows an exemplary diagram of a network participant supervising software code suitable for execution by a hardware processor of the systems shown by FIGS. **1** and **2**, according to one implementation.

DETAILED DESCRIPTION

The following description contains specific information pertaining to implementations in the present disclosure. One skilled in the art will recognize that the present disclosure may be implemented in a manner different from that specifically discussed herein. The drawings in the present application and their accompanying detailed description are directed to merely exemplary implementations. Unless noted otherwise, like or corresponding elements among the figures may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present application are generally not to scale, and are not intended to correspond to actual relative dimensions.

As stated above, a large organization, such as a government entity, large corporation, or university, for example may utilize a communication network having thousands or hundreds of thousands of technology nodes. Each of those nodes may correspond to a technology device, such as a personal communication device or client computer system, for example, or to a software application used across the network. In such a use environment, identification of the owner or administrator of each technology device and software application can be important for effective management of the network.

As also stated above, conventional solutions for managing an organizational network tend to rely on pre-registration of network device or application owners and administrators, or seek to identify a network connected device or application directly. The process for identifying a technology device or application according to the conventional approach often includes a relatively costly and inconvenient manual investigation to identify its owner or administrator.

The present application discloses a network supervision solution that overcomes the drawbacks and deficiencies in the conventional art. The present network supervision solution is an automated solution that detects an anonymously administered node of a supervised network and aggregates system log files of the anonymously administered node. By performing an analysis of the system log files using an unsupervised machine learning algorithm, the present solution advantageously enables identification of the administrator of the previously anonymously administered network node without requiring a manual investigation. The present network supervision solution then generates a registration record associating the administrator with the previously anonymously administered node and automatically updates a network participant registry using the registration record. The disclosed solution herein is able to identify anonymously administered nodes on the network, and use unsupervised learning, based on the logs, to identify the administer.

FIG. **1** shows a diagram of an exemplary automated network supervision system, according to one implementation. As shown in FIG. **1**, network supervision system **100** includes computing platform **102** having hardware processor **104**, and system memory **106** implemented as a non-transitory storage device. According to the present exemplary implementation, system memory **106** stores network participant supervising software code **110** and network participant registry **120**.

As further shown in FIG. **1**, network supervision system **100** is implemented within a use environment including network **130** having network communication links **132**, known network nodes **134***a* and **134***b*, and anonymously administered node **136**, as well as user device **150** including display **158**. It is noted that computing platform **102** of network supervision system **100** and user device **150** may be other known network nodes of network **130**. Also shown in FIG. **1** are user **140** of user device **150**, detection data **142**, system log files **138** of anonymously administered node **136**, and registration record **112** for anonymously administered node **136** produced using network participant supervising software code **110**.

It is noted that although FIG. **1** depicts network participant supervising software code **110** as being stored in its entirety in memory **106**, that representation is merely provided as an aid to conceptual clarity. More generally, network supervision system **100** may include one or more computing platforms corresponding to computing platform **102**, such as computer servers for example, which may be co-located, or may form an interactively linked but distributed system, such as a cloud based system, for instance.

As a result, hardware processor **104** and system memory **106** may correspond to distributed processor and memory resources within network supervision system **100**. Thus, it is to be understood that various portions of network participant supervising software code **110**, such as one or more of the modules described below by reference to FIG. **4**, may be stored and/or executed using the distributed memory and/or processor resources of network supervision system **100**.

In some implementations, computing platform **102** of network supervision system **100** may correspond to one or more web servers, accessible over a packet-switched network such as the Internet, for example. Alternatively, computing platform **102** of network supervision system **100** may correspond to one or more computer servers supporting a local area network (LAN), or included in another type of private communication network. That is to say, in some implementations, network **130** may be a private network.

Known network nodes **134***a* and **134***b*, and anonymously administered node **136** may correspond to client systems of network **130**. Examples of such client systems include a variety of hardware including computer work stations, portable computing devices, mobile communication devices, switches, routers, repeaters, and the like. Alternatively, or in addition, one or more of known network nodes **134***a* and **134***b*, and/or anonymously administered node **136** take the form of a network interface of a software application utilized on network **130**.

Although user device **150** is shown as a desktop computer in FIG. **1**, that representation is also provided merely as an example. More generally, user device **150** may be any suitable mobile or stationary computing device or system that implements data processing capabilities sufficient to provide a user interface, support connections to network **130**, and implement the functionality ascribed to user device **150** herein. For example, in other implementations, user device **150** may take the form of a laptop computer, tablet computer, or smartphone, for example.

User **140**, who may be a security officer or administrator of network **130**, for example, may utilize user device **150** to interact with network supervision system **100**. In some implementations, for example, user **140** may provide detection data **142** for facilitating detection of the presence of anonymously administered node **136** on network **130** by network participant supervising software code **110**.

It is noted that, in various implementations, registration record **112** for anonymously administered node **136**, when generated using network participant supervising software code **110**, may be stored in network participation registry **120** and/or may be copied to non-volatile storage (not shown in FIG. **1**). Alternatively, or in addition, as shown in FIG. **1**, in some implementations, registration record **112** for anonymously administered node **136** may be sent to user device **150** for storage, and or display to user **140** by display **158**. It is further noted that display **158** may take the form of a liquid crystal display (LCD), a light-emitting diode (LED) display, an organic light-emitting diode (OLED) display, or another suitable display screen that performs a physical transformation of signals to light.

FIG. **2** shows exemplary system **250** and computer-readable non-transitory medium **222** including instructions for performing automated network supervision, according to one implementation. System **250** includes computing platform **252** having hardware processor **254** and system memory **256**, interactively linked to display **258**. Display **258** may take the form of an LCD, LED display, an OLED display, or another suitable display screen that performs a physical transformation of signals to light. System **250** including computing platform **252** having hardware processor **254** and system memory **256** corresponds in general to network supervision system **100** including computing platform **102** having hardware processor **104** and system memory **106**, in FIG. **1**. Consequently, system **250** may share any of the characteristics attributed to corresponding network supervision system **100** by the present disclosure.

Also shown in FIG. **2** is computer-readable non-transitory medium **222** having network participant supervising software code **210** stored thereon. The expression "computer-readable non-transitory medium," as used in the present application, refers to any medium, excluding a carrier wave or other transitory signal, that provides instructions to hardware processor **254** of computing platform **252**. Thus, a computer-readable non-transitory medium may correspond to various types of media, such as volatile media and non-volatile media, for example. Volatile media may include dynamic memory, such as dynamic random access memory (dynamic RAM), while non-volatile memory may include optical, magnetic, or electrostatic storage devices. Common forms of computer-readable non-transitory media include, for example, optical discs, RAM, programmable read-only memory (PROM), erasable PROM (EPROM), and FLASH memory.

According to the implementation shown in FIG. **2**, computer-readable non-transitory medium **222** provides network participant supervising software code **210** for execution by hardware processor **254** of computing platform **252**. Network participant supervising software code **210** corresponds in general to network participant supervising software code **110**, in FIG. **1**, and is capable of performing all of the operations attributed to that corresponding feature by the present disclosure.

The functionality of network participant supervising software code **110**/**210** will be further described by reference to FIG. **3** in combination with FIGS. **1**, **2**, and **4**. FIG. **3** shows flowchart **360** presenting an exemplary method for use by a system, such as network supervision system **100**, in FIG. **1**, or system **250**, in FIG. **2**, for performing automated network supervision. With respect to the method outlined in FIG. **3**, it is noted that certain details and features have been left out of flowchart **360** in order not to obscure the discussion of the inventive features in the present application.

FIG. **4** shows exemplary network participant supervising software code **410** suitable for execution by hardware processor **104**/**254** of the respective systems shown by FIGS. **1** and **2**, according to one implementation. As shown in FIG. **4**, network participant supervising software code **410** may include network mapping module **482**, system log file aggregation module **484**, analysis module **486**, and registration module **488**. Also shown in FIG. **4** are detection data **442**, system log files **438** including individual system log files **472***a* and **472***b*, aggregated system log file data **474**, identification data **476** identifying the administrator of anonymously administered node **136**, and registration record **412** for anonymously administered node **136**.

Detection data **442**, system log files **438**, and registration record **412** correspond respectively in general to detection data **142**, system log files **138**, and registration record **112**, in FIG. **1**, and may share any of the characteristics attributed to those corresponding features by the present disclosure. Moreover, network participant supervising software code **410** corresponds in general to network participant supervising software code **110/210**, in FIGS. **1** and **2**, and those corresponding features may share the characteristics attributed to any corresponding feature by the present disclosure. Thus, like network participant supervising software code **410**, network participant supervising software code **110/210** may include modules corresponding to network mapping module **482**, system log file aggregation module **484**, analysis module **486**, and registration module **488**.

Referring now to FIG. **3** in combination with FIGS. **1**, **2**, and **4**, flowchart **360** begins with detecting anonymously administered node **136** of network **130** (action **361**). Anonymously administered node **136** of network **130** may be detected by network participant supervising software code **110/210/410** of network supervision system **100**, executed by hardware processor **104/254**.

Anonymously administered node **136** of network **130** may be detected by network supervision system **100** in a number of ways. In some implementations, detection of anonymously administered node **136** may be performed as an automated process by network supervision system **100**. For example, in those implementations, network supervision system **100** may automatically poll or probe network **130** for the presence of anonymously administered node **136**. In one such implementation, for example, network participant supervising software code **110/210/410**, executed by hardware processor **104/254** may utilize network mapping module **482** to compare anonymously administered node **136** with registration records for known network nodes stored in network participant registry **120**.

Alternatively, or in addition, network supervision system **100** may detect anonymously administered node **136** based on detection data **142/442** received from user **140**. As noted above, user **140** may be a security officer or administrator of network **130** and may detect the presence of anonymously administered node **136** in the course performing network maintenance or supervision. Detection data **142/442** may be received by network mapping module **482** of network participant supervising software code **110/210/410** and may be used to reference registration records stored in network participant registry. For example, network mapping module **482** may be used by network participant supervising software code **110/210/410** to reference network participation registry to identify the administrator of anonymously administered network node **136**, or to confirm that the administrator of anonymously administered node **136** is presently unknown.

Flowchart **360** continues with aggregating system log files **138/438** of anonymously administered node **136** (action **362**). System log files **138/438** may include any data typically stored as system log data, as known in the art. For example, system log files **138/438** may comply with the RFC5424 Syslog protocol, which is hereby incorporated fully by reference into the present application.

Aggregation of system log files **138/438** of anonymously administered node **136** may be performed by network participant supervising software code **110/210/410**, executed by hardware processor **104/254**, and using system log aggregation module **484**. The aggregation of system log files **138/438** by system log aggregation module **484** of participant supervising software code **110/210/410** may be performed via communication network **130**. In one implementation, the aggregation of system log files **138/438** may include receiving system log files **138/438** in one or more data dump(s) obtained from anonymously administered node **136**. However, in other implementations, the aggregation of system log files **138/438** may be a gradual process in which system log aggregation module **484** of participant supervising software code **110/210/410** collects system log files **138/438** from anonymously administered node **136** over time.

Flowchart **360** continues with performing an analysis of system log files **138/438** using an unsupervised machine learning algorithm (action **363**). As shown in FIG. **4**, in one implementation, network participant supervising software code **110/210/410**, executed by hardware processor **104/254**, may utilize analysis module **486** to analyze system log files **138/438** based on aggregated system log file data **474** received from system log aggregation module **484**.

Analysis module **486** may execute one or more unsupervised machine learning algorithms to perform the analysis based on aggregated system log file data **484**. For example, in one implementation, analysis module **486** of network participant supervising software code **110/210/410** may rely on one of cluster analysis, or application of a radial basis function network for the analysis of aggregated system log file data **474**. Alternatively, or in addition, analysis module **486** of network participant supervising software code **110/210/410** may utilize an expectation-maximization (EM) algorithm, either alone, or in combination with a generative topographic map (GTM) to analyze aggregated system log file data **474**. It is noted that cluster analysis, application of a radial basis function network, the EM algorithm and GTM are merely a few exemplary unsupervised machine learning techniques suitable for use by analysis module **486** of network participant supervising software code **110/210/410**.

Flowchart **360** continues with identifying the administrator of anonymously administered node **136** based on the analysis performed in action **363** (action **364**). Identification of the administrator of anonymously administered node **136** may be performed by network participant supervising software code **110/210/410**, executed by hardware processor **104/254**, and also using analysis module **486**.

The analysis of aggregated system log file data **474** performed in action **463** may reveal characteristics of anonymously administered node **136** that are shared in common with other known network nodes of network **130**, such as one or more of known network nodes **134***a* and **134***b*. For example, analysis of aggregated system log file data **474** may reveal that anonymously administered node **136** routinely runs a software application that is also run by other known network nodes administered by a single organization, such as a corporate subdivision or subsidiary. Alternatively, or in addition, analysis of aggregated system log file data **474** may reveal that anonymously administered node **136** is consistently accessed by a user who logs on to anonymously administered system node **136** with a user identification (user ID) or department ID that can be identified, for example, by reference to network participant registry **120**.

Thus, in various implementations, the administrator of anonymously administered network node **136** may be identified as one of a specific organization having control over anonymously administered node **136**, a department within the organization, or an individual person using anonymously administered network node **136**. Identification of the administrator of anonymously administered network node **136** in action **364** results in generation of identification data **476** by analysis module **486** of network participant supervising software code **110/210/410**. As shown in FIG. **4**, identification data **476** is provided as an output by analysis module **486** to update network mapping module **482**, as well as for use by registration module **488**.

Flowchart **360** continues with generating registration record **112/412** associating the administrator identified in action **364** with anonymously administered node **136** (action

365). Registration record **112/412** may include substantially all data required to produce or update an entry in network participant registry **120**. For example, registration record **112/412** may include a network address of anonymously administered network node **136** on network **130**, and data and/or resource accessing rights and constraints of anonymously administered network node **136**, as well as identifying the administrator of anonymously administered network node **136**. Generation of registration record **112/412** may be performed by network participant supervising software code **110/210/410**, executed by hardware processor **104/254**, and using registration module **488**.

Flowchart **360** can conclude with updating network participant registry **120** using registration record **112/412** (action **366**). Updating of network participant registry **120** using registration record **112/412** may be performed by network participant supervising software code **110/210/410**, executed by hardware processor **104/254**. In addition to its use for updating network participant registry **120**, in some implementations, registration record **112/412** for anonymously administered node **136** may be sent to user device **150** or system **250** for storage, and or display to user **140** by display **158/258**.

As a result of actions **361**, **362**, **363**, **364**, **365**, and **366** (hereinafter "actions **361-366**"), which may be performed in an automated process by network supervision system **100**, the administrator of anonymously administered node **136** is identified and included in network participant registry **120**. Consequently, anonymously administered network node **136** advantageously becomes another known network node of network **130**. Actions **361-366** may be repeated in each instance in which an anonymously administered node of network **130** is detected, thereby advantageously providing a robust automated network supervision solution.

Thus, the present application discloses an automated network supervision solution. The present network supervision solution detects an anonymously administered node of a supervised network and aggregates system log files of the anonymously administered node. By performing an analysis of the system log files using an unsupervised machine learning algorithm, the present solution advantageously enables identification of the administrator of the previously anonymously administered network node without requiring a manual investigation. The present network supervision solution then generates a registration record associating the administrator with the previously anonymously administered node and automatically updates a network participant registry using the registration record.

From the above description it is manifest that various techniques can be used for implementing the concepts described in the present application without departing from the scope of those concepts. Moreover, while the concepts have been described with specific reference to certain implementations, a person of ordinary skill in the art would recognize that changes can be made in form and detail without departing from the scope of those concepts. As such, the described implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present application is not limited to the particular implementations described herein, but many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

What is claimed is:

1. A network supervision system comprising:

at least one computing platform coupled to a plurality of nodes of a network including the at least one computing platform, the at least one computing platform including a hardware processor and a system memory storing a network participant supervising software code and a network participant registry;

the hardware processor configured to execute the network participant supervising software code to:

detect an anonymously administered node of the network;

aggregate a plurality of system log files of the anonymously administered node;

perform an analysis of the plurality of system log files using an unsupervised machine learning algorithm;

identify an administrator of the anonymously administered node based on the analysis;

generate a registration record associating the administrator with the anonymously administered node; and

update the network participant registry using the registration record.

2. The network supervision system of claim **1**, wherein the administrator is identified as at least one of an organization having control over the anonymously administered node and a department within the organization.

3. The network supervision system of claim **1**, wherein the administrator is identified as an individual person using the anonymously administered node.

4. The network supervision system of claim **1**, wherein the anonymously administered node comprises a client system of the network.

5. The network supervision system of claim **4**, wherein the anonymously administered node comprises a network interface of a software application.

6. The network supervision system of claim **1**, wherein the network is a private network.

7. The network supervision system of claim **1**, wherein the network supervision system comprises a cloud based, distributed system.

8. A method for use by a network supervision system including at least one computing platform coupled to a plurality of nodes of a network including the at least one computing platform, the at least one computing platform including a hardware processor and a system memory storing a network participant supervising software code and a network participant registry, the method comprising:

detecting, using the hardware processor, an anonymously administered node of the network;

aggregating, using the hardware processor, a plurality of system log files of the anonymously administered node;

performing an analysis of the plurality of system log files, using the hardware processor and an unsupervised machine learning algorithm;

identifying, using the hardware processor, an administrator of the anonymously administered node based on the analysis;

generating, using the hardware processor, a registration record associating the administrator with the anonymously administered node; and

updating, using the hardware processor, the network participant registry using the registration record.

9. The method of claim **8**, wherein the administrator is identified as at least one of an organization having control over the anonymously administered node and a department within the organization.

10. The method of claim **8**, wherein the administrator is identified as an individual person using the anonymously administered node.

11. The method of claim **8**, wherein the anonymously administered node comprises a client system of the network.

12. The method of claim **8**, wherein the anonymously administered node comprises a network interface of a software application.

13. The method of claim **8**, wherein the network is a private network.

14. The method of claim **8**, wherein the network supervision system comprises a cloud based, distributed system.

15. A computer-readable non-transitory medium having stored thereon instructions, which when executed by a hardware processor of a computing platform interactively coupled to a network, instantiate a method comprising:

detecting an anonymously administered node of the network;

aggregating a plurality of system log files of the anonymously administered node;

performing an analysis of the plurality of system log files using an unsupervised machine learning algorithm;

identifying an administrator of the anonymously administered node based on the analysis;

generating a registration record associating the administrator with the anonymously administered node; and

updating a network participant registry using the registration record.

16. The computer-readable non-transitory medium of claim **15**, wherein the administrator is identified as at least one of an organization having control over the anonymously administered node and a department within the organization.

17. The computer-readable non-transitory medium of claim **15**, wherein the administrator is identified as an individual person using the anonymously administered node.

18. The computer-readable non-transitory medium of claim **15**, wherein the anonymously administered node comprises a client system of the network.

19. The computer-readable non-transitory medium of claim **15**, wherein the anonymously administered node comprises a network interface of a software application.

20. The computer-readable non-transitory medium of claim **15**, wherein the network is a private network.

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